Assessment of Advanced Behaviours for Assistive Robotic Wheelchairs

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Declaration of Authorship

I, **Bojan Andonovski**, certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signed:

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Abbreviations

2D	Two Dimensional
ADL	Activities of Daily Living
AMCL	Adaptive Monte Carlo Localisation
ARMA	AutoRregesssive Moving-Average
AT	Assistive Technology (AT)
ATOM	Assistive Technology Outcome Measure
AR	AutoAegressie
BN	Bayesian Network
CAS	Centre of Autonomous Systems
DBN	Dynamic Bayesian Network
EKF	Extended Kalman Filter
EKG	Electrocardioraph
FIM	Functional Independence Measure
FEW-Q	Functional Evaluation in a Wheelchair Questionnaire
GUI	Graphical User Interface

HMM	Hidden Markov Model
IR	Infra Red
IPW	Intelligent Power Wheelchair
IMU	Inertial Measurement Unit
IWS	Intelligent Wheelchair System
KDD	Knowledge Discovery from Databases
KNN	K-Nearest Neighbors
MCL	Monte Carlo Localisation
MA	Moving-Average
MDP	Markov Decision Process Models
LPC	Linear Prediction Coding
OCAWUP	Obstacle Course Assessment of Wheelchair User Performance
OT	Occupational Therapist
OTFACT	Occupational Therapy Functional Assessment Compilation Tool
PCDA	Power-Mobility Community Driving Assessment
PIADs	Psychosocial Impact of Assistive Devices
PIDA	Power-Mobility Indoor Driving Assessment
PMD	Powered Mobility Devices
PoW	Prince of Wales Hospital
ROS	Robot OPerating System

POMDP	Partially Observable Markov Decision Process
PN	Probabilistic Networks
RF	Random Forest
SLAM	Simultaneous Localisation and Mapping
SVM	Support Vector Machine
UTS	University of Technology Sydney
WhOM	Wheelchair Outcome Measure
WST	Wheelchair Skills Test
WST-P	Wheelchair Skills Test Powered

Abstract

Research demonstrates that use of appropriate Assistive Technology (AT) is associated with increased independence and reduced need for ongoing care and support. Powered mobility devices (PMDs) such as power wheelchairs and scooters are proving to be useful pieces of assistive technology. This study focuses on developing and assessing the validity of a stand-alone sensor package and algorithms to help the assessment by an Occupational Therapists (OT) whether a person has the capacity to safely and efficiently operate a powered mobility device such as a wheelchair in their daily activities. This is accomplished by analysing data computed from a standalone sensor package fitted on a wheelchair platform. The proposed solution consists of a suite of sensors capable of inferring navigational features from the platform it is attached to (e.g. trajectories, map of surroundings, speeds, distance to doors, etc). The study aims to compare and contrast objective data derived from a PMD mounted sensor package with subjective data obtained using a standard Occupational Therapy assessment. The research work demonstrated that accurate, reliable objective data from a sensor package can be used to augment the Occupational Therapists subjective assessment. Furthermore, the task-specific parameters that may provide the most relevant user information for the assessment are automatically revealed through a machine learning approach. Machine learning automated assessment classification tests, with data attained from multiple runs of able clients simulating varying degrees of erraticness in their driving skills while they performed the assessment tasks, have indicated success rates in the order of 85%.